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Summary

This paper aims to contribute to the existing knowledge on Technology Roadmapping (TRM) and considers the current practices. A recently completed literature review on TRM has thus far highlighted the obvious lack of importance placed on SMEs within the TRM process for partner selection. This developmental paper seeks to explore and understand the current academic literature in TRM as well considering the relevance of such practices for SMEs.

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1. Introduction

The popularity of TRM has increased over the years, particularly given the use of TRM by Motorola in the 1980s. TRM purports to allow its users to anticipate market and technological changes as these interact, and to develop a corporate strategy that is both market and technology-oriented so enhancing that strategy's chances of success (Vatananan & Gerdsri, 2010). With such a vast array of information available and the importance placed on TRM, academics, researchers and policy-makers see TRM as a device for technology management and industrial policy planning with signs indicating that this can become a reliable procedure in future technological planning, and may even be utilised to lead strategy policy and operation levels (Choomon & Leeprechanon, 2011). It provides a framework for linking business directly to technology and is widely within industry by individual firms, government and consortia (Lee, Kang, Park, & Park, 2007).

There has been much emphasis placed on communication, which ideally creates a dialogue of alignment with customers as well as suppliers (Albright & Kappel, 2003). However, within this theme of communication there has been little effort to advance the discussion of TRM in the academic literature with respect to technology-push integration where the need to develop a roadmapping method specific to the situation considers partnerships is considered (Caetano & Amaral, 2011). With respect to partnerships, there are "studies suggesting the involvement of partners in technology roadmapping" (Gerdsri, Vatananan, & Dansamasatid, 2009; Phaal, Farrukh, & Probert, 2001; Wells, Phaal, Farrukh, & Probert, 2004) as well as authors that propose identification of partners (Daim & Oliver, 2008; Lee, Yoon, Lee, & Park, 2009; Lichtenthaler, 2010). However, neither the studies or authors have a system of identification, selection, prioritisation and incorporation of partners into roadmapping or take into account the different types of partners to be identified" (Caetano & Amaral, 2011, p. 12).

This paper examines how the partners, specifically SMEs, can engage with one another and with larger companies to collaborate in developing TRM either as partners or as suppliers. What is required is to highlight how these relationships can be sought out, built and utilised. The paper seeks to develop an understanding of the nature of relationships between customers, manufacturers and suppliers with respect to the technology. While relationships are often established easily in the new product development processes (Handfield & Lawson, 2007), it is still key to identify these relationships explicitly within the literature.

2. The Under-representation of SMEs in the TRM Literature

The TRM literature lacks a focus on methods for firms, including SMEs, to adapt and adopt technology-push integration strategies to develop products and services from just an idea or technology opportunity. Caetano & Amaral (2011) suggest developing a roadmapping method specific to an SME's situation, which takes partnerships into account. The literature on roadmapping methods has been created to suit the context of large corporations, which combine R&D and product development structures i.e. organisations that mainly adopt the market-pull strategy and closed innovation technologies to be developed based on specific market needs (ibid). In a rare case, Holmes and Ferrill (2005) applied technology roadmapping to aid Singaporean SMEs in identifying and selecting emerging technologies. The introduction in the SME manufacturing sector in Singapore aimed to improve the future outlook of these companies from the normal 4-6 months to an average of 3-5 years, allowing

the firms to think and plan future developments but in companies this size it was evident that there was a blur between strategic technology planning processes and traditional business strategy.

From the literature there is a lack of proposals to guide firms in selecting partners and incorporating these systematically in roadmapping. Studies may cite partners, but do not advance any specific steps and tools in this direction (Caetano & Amaral, 2011). Cosner et al. (2007) are a partial exception in illustrating how roadmapping provides a mechanism to capitalise on the scale of operations by documenting key business goals and R&D projects which enable synergies to be identified. However, the synergies that they discuss are within their own organisation. It has been acknowledged that too often it is larger firms that have been targeted for TRM as they tend to have longer-term contracts and are driven by long-term planning, being business-driven rather than market-driven, unlike most SMEs (Gindy, Cerit, & Hodgson, 2006). Larger organisations that do implement TRM often do not want to involve SMEs or other external stakeholders as they have in-house teams, departments and managers to undertake such processes and to foresee what their product will look like and what markets will benefit from it, therefore little value is added to seeking out SMEs (who may not be able to incorporate or guarantee that they will be able to remain in the market themselves given the longer-term scales). An example of this is Cisco, which employed a mergers and acquisition strategy to concentrate on internal partners to provide the necessary capabilities in complementary areas to support them, which were far too complex to be completely developed by a single company (Li, 2009).

Also in practice, many TRMs are designed to contain information for strategic use and often do not contain enough details for operational use (Savioz & Blum, 2002). This may cause problems the strategic issues within TRM are rendered operational during implementation (Probert & Shehabuddeen, 1999). It has been argued that these strategic approaches are not meant to be used in smaller companies (ibid). Farrukh, Phaal and Probert (2001) argue that although TRM is gaining prominence in the UK, TRM suits larger companies where smaller companies can make use of the practice, with less complex products and technologies. However, an attempt to overcome this is Opportunity Landscape, which brings together technological intelligence and strategic planning by using the SME specific strengths and vice versa (Savioz & Blum, 2002). However, the use of Opportunity Landscape builds and is strongly dependent on an open-minded company culture and a serious commitment of top management if they are to be involved within roadmapping processes (ibid).

3. The Open Innovation Agenda, SME's and Technology Planning

The open innovation agenda has the potential to challenge the orthodoxy that TRMs are the sole province of larger firms. It has been suggested that open innovation is an important way for SMEs to have access to market information and necessary technologies to combine with their own competent technology, in order to create value for customers. The practical application of the open innovation approach on SMEs starts with technology-push environments. Using the concept of open innovation it is possible to think about a method such as TRM, specifically designed for SMEs and technology push environments. It helps to expand the absorptive capacity of SMEs bringing benefit from open innovation paradigms and relating positively with their environment in order to capture, transform and exploit the knowledge needed for innovation (Igartua, Garrigós, & Hervas-Oliver, 2010). However, larger companies may not be willing to implement the roadmap to include others. For example in Lichtenhaler's (2010) case study of a large machinery company, many of the

firm's employees were relatively reluctant to licence technology. This reluctance was not expressed with respect to the roadmap tool, but rather with regard to the transfer of proprietary technology in general. There was "fear to commercialize the crown jewels, many employees first wanted to pursue a relatively closed innovation approach" (Lichtenthaler, 2010, p. 433).

Therefore, an open innovation approach may not at first seem ideal and needs to be considered carefully with respect to the company itself and its 'crown jewels'. Sharing knowledge may encourage opportunistic behaviour when knowledge asymmetries occur, as well as behaviourally conditioning firms to trust less if they experience negative effects from sharing too early on, or incur more negative than positive experiences (Petrick & Echols, 2004), thus external technology exploitation involves considerable risk. In particular it may result on strengthening competitors by diffusing competitive know-how (Lichtenthaler, 2008). Also leakages may accidentally or strategically occur causing some firms who are highly skilled at something to lose out to less competent partners.

Furthermore, a study undertaken by Minshall, Mortara, Valli, and Probert (2010) highlights that 'asymmetric' partnerships between technology-based start-ups and large firms can look to open innovation but indicates many challenges faced by the SMEs, the larger organisations and by the potential investors. Such challenges for SMEs include contacting the right person, the unrealistic demands made on the SME by the larger firms or the speed at which large firms operate, where many layers of management and bureaucracy may delay the process for SMEs. Large firms also face challenges of partnering up with SMEs, they are reluctant to reveal details of their technology without legal formalities i.e. non-disclosure agreement, the time and cost involved in illustrating the product to the SME or even the start-ups being run by individuals who do not want to lose the governance and autonomy of their company. The authors do not stop there; they identify management approaches to meeting the challenges of such partnerships. These partnerships could possibly be aligned with TRM to highlight the missing link or bridge the gap in some way between the larger organisations and SMEs. However, at the same time TRM is simply a tool that can enable firms to make more sustainable new product decisions. Bearing this in mind, it can prevent the waste of time and resources, reduce risks and uncertainty and as a result increase the accuracy of making profitable decisions (Lichtenthaler, 2008). Thus so far outweighs the costs of roadmapping.

4. Government Enterprise Policy

TRM has also gathered interest from government, who have been interested in promoting roadmaps to facilitate the development of competitive industries and to push science and technology forward (McDowall, 2011). There has been an evident shift from industry to public policy; the nature of TRM activities has been on developing partly as a process of setting directions for the social goals, such as low-carbon technologies (McDowall, 2011) or sustainable energy (Foresight, 2008). The government has been increasingly using roadmapping approaches in technology, particularly in the context of energy policy and the transition to a low-carbon energy system (Amer & Daim, 2010). For example The Ministry of Economy, Trade and Industry in Japan has actively involved itself in TRM since 2003 (Yasunaga, Watanabe, & Korenaga, 2009). Yasunaga et al. (2009) developed what they call the IS-Plan (Innovation Strategy) to involve SMEs which have specific and unique competencies and technologies in the markets they operate. They argue that such enterprises often seek new applications for their technologies from their study indicated that there were

no tangible results of whether this really works for creating business and they argued they needed more time to see if this succeeds or not.

The challenge is to capture the intricacies of TRM, which explicitly involves SMEs, and transparently within the overall picture. However, it could be that very few SMEs know of such a process and this would explain the lack of an SME agenda in the extant literature at present. It is suggested that adoption of openness concerning TRM is a promising avenue for future research and practice. It is proposed that open innovation may lead to the involvement of SMEs within the technological arena and identify collaborative relationships with respect to their capabilities.

Plans to develop the paper prior to discussion and presentation at the conference

Prior to the conference the paper will be developed significantly through undertaking four industry workshops with SMEs in different sectors (engineering, oil/gas, IT/creative and life sciences) and also a policy workshop with respect to the implications for government with the use of such practices. From the information gathered at the workshops and from the academic literature review, linkages between the fundamental gap in the TRM literature and SMEs can be further highlighted and the implications for the TRM process considered. Presenting the paper at BAM will present the opportunity for colleagues to assess and comment on the implications and conclusions, particularly the use of such a tool for SMEs.

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